



# Cloud Property Retrievals: Case Studies from CRYSTAL-FACE

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One of the objectives of CRYSTAL-FACE is to improve the Earth system modeling and data assimilation through the use of observations, including those from satellite observing systems. We focus on the improvement of cloud property retrievals through the combination of data from two satellite instruments, ground-based radar, and models of cloud microphysical properties.

The MODIS (Moderate-Resolution Imaging Spectroradiometer and AIRS (Atmospheric Infrared Sounder) instruments differ greatly in both spatial and spectral resolution. MODIS measures Earth radiances in two visible bands at 250 m resolution, in five other visible bands at 500 m resolution and the remaining 22 bands at 1 km resolution. AIRS measurements are at 13.5 km resolution in the 2378 infrared bands and at 2.3 km in four visible and near-infrared bands.

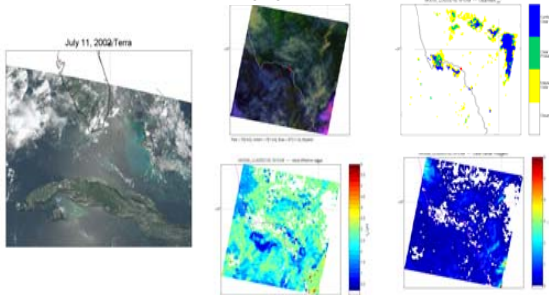
Our goal is to use combined instrumentation to derive cloud properties. This poster demonstrates:

- 1) Operational MODIS cloud effective radius and optical thickness retrievals (MOD06),
- 2) Radiative transfer simulations of MODIS data with cloud boundaries specified by radar,
- 3) High-spectral resolution based cloud property retrievals

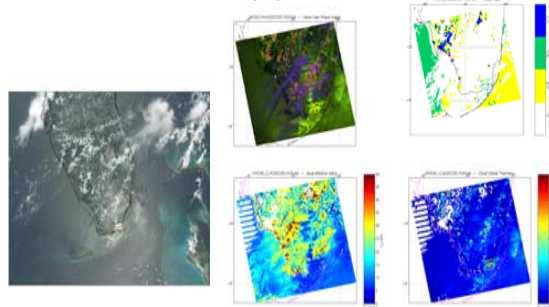
## MODIS Retrievals for CRYSTAL case study

Examples of MODIS observations and operational products for two days during CRYSTAL are shown below. These include true color and false color phase images, and the operations cloud detection, cloud optical depth and cloud effective radius products. Data from July 11, 2002 is from the MODIS on the Terra spacecraft. The 4 images on the right are 100 x 100 km centered around the PARSL site. Data from July 19, 2002 is from the MODIS on the Aqua spacecraft. The 4 images on the right are 200 x 200 km centered between the PARSL and Easter ground sites.

### July 11, 2002 Terra MODIS

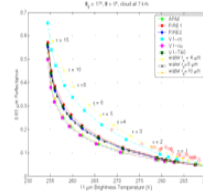
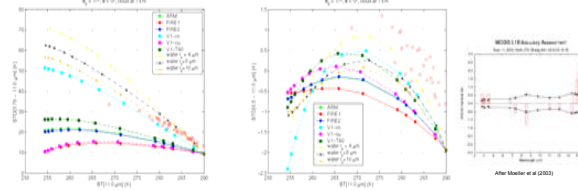


### July 19, 2002 Aqua MODIS



## MODIS Retrievals from CRYSTAL using radar boundaries

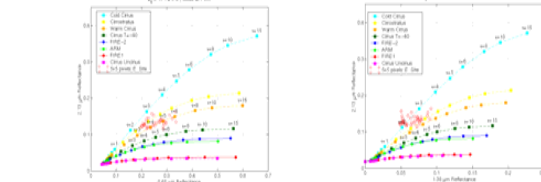
11 July, 2002



For the July 11 2002 Terra MODIS case study, the CRYSTAL calculations agree well with the operational MODIS cloud optical depth and cloud effective radius retrievals. Curves are from RT calculations with cloud heights from the PARSL cloud radar. Note that the RT simulations imply that the cloud is liquid phase. The open red circles are MODIS observations from the 25 pixels centered over the PARSL site.

The simulated BT(8.5 - 11  $\mu$ m) seem low compared with the observations. This agrees well with a study by Moeller et al. regarding the 8.5  $\mu$ m band on MODIS.

19 July, 2002



For the July 19 2002 Aqua MODIS case, the observations from the 25 pixels centered over the Eastern ground site fall between the cirrostratus and warm cirrus simulations, with  $r_e$  between 14.0 and 20  $\mu$ m and optical thickness between 3 and 6. The mean  $r_e$  from the operational product is 25.1  $\mu$ m, with a standard deviation of 3.5  $\mu$ m and the mean optical thickness is 3.6 with a standard deviation of 0.8.

## References

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## Synopsis and Future Work

Detailed examination of the retrievals for 11 and 19 July 2002 agree well with the operational products.

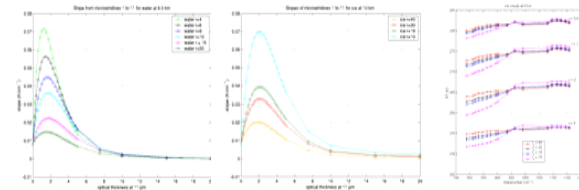
A unique cloud property retrieval capability exists on the Aqua spacecraft. Combining measurements from MODIS and AIRS will allow us to take advantage of both the high spatial resolution of MODIS and the high spectral resolution of AIRS. During CRYSTAL, we also have the capability to include cloud boundaries and cloud retrievals from ground-based radar.

To date we have demonstrated retrievals using MODIS and aircraft-based high-spectral resolution instruments and are currently working on adapting these methods to AIRS data.

Our next steps include performing cloud property retrievals using:

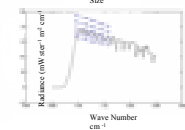
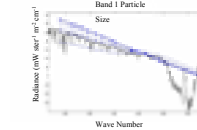
- 1) MODIS with cloud boundaries specified by radar with CRYSTAL cloud microphysics,
- 2) MODIS with radar and CRYSTAL cloud microphysics,
- 3) AIRS alone,
- 4) MODIS, AIRS, radar and CRYSTAL cloud microphysics

## Cloud properties from high-spectral resolution observations (e.g. NASTI & AIRS)

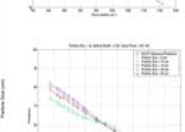
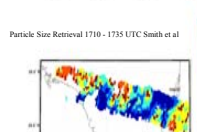
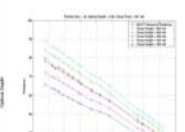
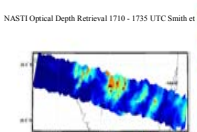


Model calculations of the slope of the brightness temperatures over the first 11 microwindows for 5 water cloud size distributions with effective radii of 10, 18, 30, and 40  $\mu$ m at an altitude of ~10 km (230 K). The maximum sensitivity to crystal size occurs for IR optical thickness near 2.

Model calculations of the slope of the brightness temperatures over the first 11 microwindows for 4 ice cloud size distributions with effective radii of 10, 18, 30, and 40  $\mu$ m at an altitude of ~10 km (230 K). The maximum sensitivity to crystal size occurs for IR optical thickness near 2.

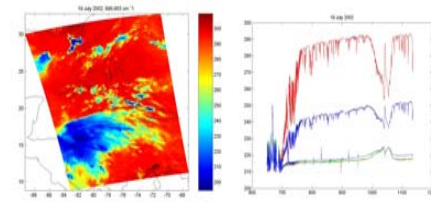


Retrieval algorithms are based on fitting RT calculations at microwindows to observed radiances.



Retrieval algorithms developed using aircraft observations (see Smith et al). Retrievals are based on micro windows and on-line and off-line observations.

## AIRS Cloud Observations



The AIRS data are of high quality but features in the data must be appropriately handled before cloud retrievals are finalized.